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Journal of the Indiana Academy of the Social Sciences

Volume 14 | Issue 1 Article 7

2010

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Economics

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ABSTRACT

There is still considerable disagreement among researchers whether trade liberalization can explain the rising wage inequality. The wage inequality between skilled workers and unskilled workers expanded in the U.S. manufacturing industries during 1980 through 2000. Meanwhile, NAFTA (North American Free Trade Agreement) has provided us with the opportunity to observe the effect of significant tariff reduction during the same period. The purpose of this paper is to examine the contribution of the reductions of U.S. import tariffs from NAFTA countries Canada and Mexico to that expanding wage inequality during 1980 through 2000. Based on the essential idea of Stolper and Samuelson (1941) and following the method of Haskel and Slaughter (2003), the relationship between product prices and U.S. tariff rates is estimated first and the effect of tariff-induced product prices on wage changes is then estimated. Based on a newly developed industrial classification code, this paper finds significant evidence that U.S. tariff reductions on both Canadian imports and Mexican imports expanded wage inequality between skilled workers and unskilled workers in U.S. manufacturing industries during the period considered. That is, a 1 percent reduction of U.S. tariffs on imports from Canada resulted in a mandated rise in the wage gap by 0.69 percent. A similar result was obtained for Mexican imports, in which a 1 percent reduction of U.S. tariffs on imports from Mexico resulted in a mandated rise in the wage gap by 0.57 percent. These results indicate that U.S. tariff reduction hurts unskilled workers in manufacturing industries, which does not match the result from Haskel and

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Slaughter (2003), who found no significant evidence that tariff reductions widened wage inequality in the United States.

KEY WORDS Trade; Tariff; Import; NAFTA

Increasing wage inequality between skilled workers and unskilled workers in U.S. manufacturing industries has attracted economists' attention, and many explanations have been offered. One of the culprits most commonly cited is trade liberalization (Borjas and Ramey 1994; Borjas, Freeman, and Katz 1997; Feenstra and Hanson 1997; Revenga and Montenegro 1998; Hanson and Harrison 1999; Hanson 2003; Robertson 2004). However, there is still considerable disagreement among researchers whether trade liberalization can explain the rising wage gap (Katz and Murphy 1992; Lawrence et al. 1993; Berman, Bound, and Griliches 1994; Harrigan and Balaban 1997; Haskel and Slaughter 1998; Katz and Autor 1999; Leamer 1999; Baldwin and Cain 2000; Harrigan 2000; Edwards and Lawrence 2010).

This paper raises again a long-term argument: the effect of trade liberalization on increasing wage inequality between the two types of workers. One of the essential ideas to consider in the argument is that of Stolper and Samuelson (1941), who proposed that the effect of trade liberalization on wages occurs through changing product prices. This idea was applied by Haskel and Slaughter (2003), who used a weighted average of U.S. tariffs on imports from all countries to measure trade liberalization and analyzed the effect of tariff reduction-induced product price changes on wages between two types of workers in U.S. manufacturing industries during 1974 through 1988. Their results, however, have shown no significant evidence that U.S. tariff reductions mandated a rise in wage inequality. This paper, using a newly developed industrial classification code applied to a different set of tariff data from a different time period than that considered by Haskel and Slaughter (2003), examines Stolper and Samuelson (1941) and finds a different result from Haskel and Slaughter (2003). U.S. tariffs on imports from countries in the North American Free Trade Agreement (NAFTA), Canada and Mexico, in the period of 1980 through 2000 are considered in this paper. U.S. tariff rates were generally declining after 1980 especially, and NAFTA has provided us with an opportunity to observe the effect of U.S. tariff reductions. Meanwhile, it can be seen that the wage gap between skilled workers and unskilled workers in U.S. manufacturing industries has widened since the early 1980s. This paper examines whether the reduction of U.S. import tariffs from Canada and Mexico, working through product prices, raises expanding wage inequality between two types of workers in U.S. manufacturing industries from 1980 through 2000.

The analysis is conducted by applying the method (mandated wage methodology with the two-stage procedure[1]) of Haskel and Slaughter (2003); that is, the relationship between product prices and U.S. tariffs and other causal variables are estimated first. This allows the portion of product price changes due to the change in U.S. tariffs to be estimated. Next, the change in wages affected by the adjustment in tariff-induced product prices is estimated. This analysis also uses all U.S. manufacturing industries described by four-digit Standard Industrial Classification (SIC) 72 for 1980 through 1986, four-digit SIC 87 for 1987 through 1996, and six-digit North American Industrial Classification System (NAICS) for 1997 through 2000.

The data consist of the U.S. import variables from all countries and U.S. industrial variables from 1980 through 2000, all of which are aggregated into 100 industries for concordance, which is newly developed by the author.

This paper finds that a 1 percent reduction of U.S. tariffs on imports from Canada, working through product price change (by –0.008 percent) mandated a fall in the wage for unskilled workers by 0.6 percent and a rise in the wage for skilled workers by 0.09 percent, resulting in a mandated rise in the wage gap by 0.69 percent. A similar result was obtained for U.S. tariff reductions on imports from Mexico, in which a 1 percent reduction of U.S. tariffs on imports from Mexico, working through product price change (by –0.009 percent), mandated a fall in the wage for unskilled workers by 0.58 percent and a rise in the wage for skilled workers by 0.01 percent, resulting in a mandated rise in the wage gap by 0.57 percent. These results indicate magnification effect. Hence, unlike Haskel and Slaughter (2003), this research concludes that U.S. tariff reductions on both Canadian imports and Mexican imports have a significant effect on expanding wage inequality between skilled workers and unskilled workers in U.S. manufacturing industries during the period considered.

The remainder of this paper is organized as follows. The model is discussed in the following section. Then the data are described, including a summary of the tariff and wage data, and specifications. Results are then given, and finally, the paper is concluded with some recommendations for future research.

MODEL

The theory of international trade (Heckscher-Ohlin model) under the traditional assumption is stated in terms of an economy with no trade barriers for which domestic product prices are set in world markets. According to Haskel and Slaughter, "Trade barriers drive a wedge between domestic prices and world prices" (2003:632). Thus, the reduction of tariff rates as one of the trade barriers for trade liberalization is focused on and the effect of product price changes mandated by U.S. tariff reductions on wages for skilled workers and unskilled workers is examined.

To implement this, the mandated wage methodology with the two-stage procedure of Haskel and Slaughter (2003) is applied. Let $i = 1, \dots\dots\dots, I$ be a factor of production and $j = 1, \dots\dots\dots, J$ be an industry. Also, suppose there is a list of K variables that affect product prices ($k = 1, \dots\dots\dots, K$). This list includes tariff rates as well as other causal variables such as transportation costs, U.S. output share, exchange rate, capital/labor ratio, and total factor productivity (TFP). Let the time period be $t = 1, \dots\dots\dots, T$. p is (J x T) x 1 vector of domestic product prices. Let Z_j be the T x K matrix consisting of elements z_{jtk} (value of the k^{th} causal variable for sector j at time t). So, $Z = (Z_1, Z_2, \dots\dots\dots, Z_j)^T$, a ($J$ x T) x K matrix of causal variables, which are assumed to drive product price changes. Let α, a parameter to be estimated with K x 1 matrix, be the effect of a 1 percent change in causal variable Z on p.

For a first-stage regression, domestic product prices on tariff rates and other causal variables, Z, are regressed and the relationship between product prices and tariff rates is estimated. This allows how much the tariff rates affect product prices to be calculated.

$$\log(p) = Z \cdot \alpha + D \cdot \delta + \varepsilon \qquad \text{first-stage regression} \qquad (1)$$

Here, ε is an error term with (J x T) x 1 vector. Estimated coefficients $\hat{\alpha}$ show how much causal variables affect product prices. $\hat{\alpha}$ does not vary by industry. This assumes the same pass-through rate from tariff to product prices across all industries; that is, all industries are treated identically.

To allow heterogeneity among industries, industry dummy variables, D, are included in equation (1). D is a (J x T) x K diagonal matrix with T x 1 column of ones in each diagonal position. δ is an estimated coefficient of D with K x 1 vector.

For a second-stage regression, the contribution to p of each causal variable, $Z \cdot \hat{\alpha}$ obtained from the first-stage regression (1) is regressed on the factor share θ to estimate the change in factor prices affected by the tariff rates-induced product prices:

$$Z \cdot \hat{\alpha} = \theta \cdot \beta + D \cdot \gamma + e \qquad \text{second-stage regression} \qquad (2)$$

where $Z \cdot \hat{\alpha}$ is (J x T) x 1 vector, θ is (J x T) x I matrix of factor share among the cost, β is a parameter to be estimated with I x 1 vector, and e is a (J x T) x 1 vector of error terms. D, dummy variable with (J x T) x K diagonal matrix, is included in equation (2) for the same reason as in equation (1). γ is an estimated coefficient of D with K x 1 vector. The second-stage regression yields $\hat{\beta}$ (estimates of β), the change in factor prices mandated by each causal variable working through p. That is, I have an estimate of the effect on the change in factor prices of product prices, which are mandated by the reduction of tariff rates. Because $\hat{\beta}_S$ is the change in the wage for skilled workers and $\hat{\beta}_U$ is the change in the wage for unskilled workers, both of which result from a 1 percent change in tariff rates, the difference between $\hat{\beta}_S$ and $\hat{\beta}_S$ tells us how the change in tariff rates affects the wage gap.

The dependent variable in the second-stage regression (2) is generated from estimates of the first-stage regression. While the estimated coefficient for the second-stage regression is still consistent (Murphy and Topel 1985), the standard error of the second-stage coefficient estimates needs to be corrected to account for the additional variance of the first-stage estimation. I have followed the procedure proposed by Dumont et al. (2005)[2] to correct the variance of the second-stage regression coefficient estimates. That is,

First-stage regression: $$\log(p) = Z \cdot \alpha + D \cdot \delta + \varepsilon \qquad (3)$$

Second-stage regression: $$Z \cdot \hat{\alpha} = \theta \cdot \beta + D \cdot \gamma + e \qquad (4)$$

Then,[3] $$Var(\hat{\beta}) = \sigma_\varepsilon^2 (\theta^T \theta)^{-1} + (\theta^T \theta)^{-1} \theta^T Z \Omega Z^T \theta (\theta^T \theta)^{-1}$$

$$= (\theta^T \theta)^{-1} [\theta^T \sigma_\varepsilon^2 \theta + \theta^T Z \Omega Z^T \theta] (\theta^T \theta)^{-1}$$

where $\Omega = \sigma_\varepsilon^2 (Z^T Z)^{-1}$.

σ_ε^2 can be estimated by $\frac{u^T u}{n-v}$, where u is estimated residual from the second-stage stage regression, v is number of columns of θ (v =3 if I use three factors of production), and n is number of observations.

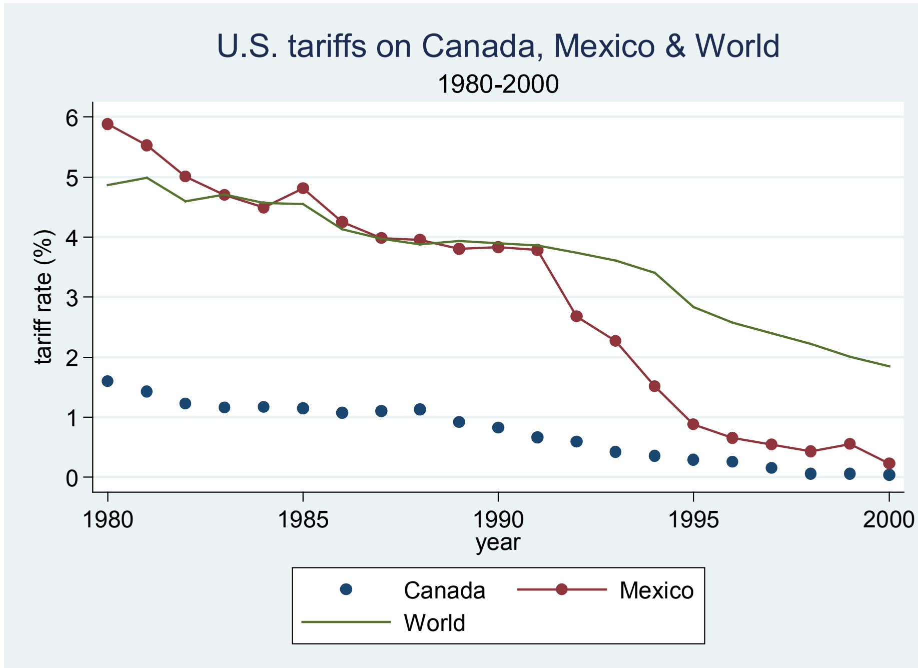
Ω is estimated by $\hat{\Omega}$, covariance matrix of $\hat{\alpha}$, which is unbiased estimator of Ω obtained from the first-stage regression.

DATA AND SPECIFICATIONS

U.S. industry data and import data for 1980 through 2000 are used. U.S. industrial data are from the Annual Survey of Manufacturing (ASM) with four-digit 1972 SIC 72 code for 1980 through 1986, ASM with four-digit 1987 SIC 87 code for 1987 through 1996, and ASM with six-digit NAICS code for 1997 through 2000. ASM is provided by U.S. Census Bureau. Import data are available from Robert C. Feenstra (1996) based on the Tariff Schedule of the United States Annotated (TSUSA) classification code for 1980 through 1988 and from Feenstra, Romalis, and Schott (2002) based on 10-digit Harmonized Tariff System (HTS 10) code for 1989 through 2000. All industrial and import data are aggregated into 100 industries for concordance because (1) numbers of industrial classification codes used in the industrial data and those in import data are different: TSUSA includes 27,000 industries, HTS 10 has about 24,000, SIC72 has 450, SIC87 has 460, and NAICS has 473 and (2) no classification code matches another classification code on a one-to-one basis. One specific classification code was therefore selected to organize the entire data set for this research. For example, industry classification code number 2048 in SIC 87 corresponds to both 311119 and 311611 in NAICS, according to the concordance between SIC 87 and NAICS. To solve this problem, two industries (311119 + 311611) in NAICS are aggregated to correspond to 2048 in SIC 87 so we have a one-to-one relationship between two different classification codes (SIC 87 and NAICS in this case). Repeating this procedure, a unique industrial classification code[4] has been created that has consistent convertibility with all six classification codes (TSUSA, HTS 10, SIC 72, SIC 87, and NAICS) and has 100 industrial classification codes. All nominal variables are converted to 1982–1984 dollars using consumer price index (CPI) for all urban consumers (CPI-U).

There are missing observations among both the industry data and the import data. For industrial data, most of them occur in capital expenditures from 1980 through 1999. Using the 2-digit and 3-digit SIC code and this unique code, I made up values for the missing observations. In case the values could not be made up, however, they were left blank.[5] For import data, missing values were also left blank.

Before a specification is described, tariff data and wage data are summarized as below. The tariff rate for a given commodity is calculated as total duties collected as a share of the total customs value of imports for consumption. Here, to get a general picture of the changing tariff climate, average tariff rates are presented. U.S. tariffs on imports were generally declining from 1980 through 2000, as can be seen in Figure 1, which shows the U.S. tariff rate on imports from Canada, imports from Mexico, and a weighted average of U.S. tariffs on imports from all countries (worldwide). The decline of tariff rates with Canada accelerated sharply with the U.S.–Canada FTA in 1988, and the tariff rates on imports from Mexico declined sharply with the U.S.–Mexico FTA in 1994. In both cases, the tariff rates became close to 0 percent around 2000 and have remained there since then. These sharp declines of tariff rates after the beginning of the FTAs can be seen more clearly in Table 1. Meanwhile, the weighted average of U.S. tariff on imports from all countries (worldwide) declined from about 5 percent to about 2 percent in 2000 and has remained there since then.



Note: World shows weighted average of U.S. tariffs on imports from all countries.

Sources: Feenstra (1996) for 1980–1988; Feenstra, Romalis, and Schott (2002) for 1989–2000. See text for details of construction of tariff rate. All calculations are by the author.

Figure 1. U.S. Tariffs on Canada and Mexico and Worldwide, 1980–2000

Wage data for both skilled workers and unskilled workers are from the ASM from 1980 through 2000. Data for production workers in the ASM are used to measure unskilled workers, and data for non-production workers (total workers minus production workers) in the ASM are used to measure skilled workers. All nominal wages are converted to 1982–1984 dollars using CPI-U.

Overall movement of real wages for skilled and unskilled workers in U.S. manufacturing industries from 1980 through 2000 is summarized in Figure 2. There was generally an upward trend since the early 1980s for real wages of skilled workers, while no general trend could be seen for unskilled workers. From 1980 to 2000, the average real wage of skilled workers increased by about 18.0 percent, while the average real wage of unskilled workers increased by only 1.7 percent, resulting in an increase in a relative wage of skilled workers to unskilled workers, as seen in Figure 3. The relative wage of skilled workers to unskilled workers is calculated as real wage for skilled workers as a share of real wage for unskilled workers.

Table 1. Change of U.S. Tariffs in Relation to Free Trade Agreements

	U.S.–Canada[a]		U.S.–Mexico[a]	
	%change	Average annual change	%change	Average annual change
1980–2000	–97.3%	–16.5%	–96.1%	–15.0%
Pre FTA	–30.8% (1980–1987)	–5.1% (1980–1987)	–68.7% (1980–1993)	–5.9% (1980–1993)
Post FTA	–96.1% (1988–2000)	–23.7% (1988–2000)	–78.20 (1994–2000)	–14.13% (1994–2000)

	U.S.–World[b]	
	%change	Average annual change
1980–2000	–62.0% (1980–2000)	–4.7% (1980–2000)

Notes: [a] The U.S.–Canada FTA was in effect in 1988, and the U.S.–Mexico FTA was in effect in 1994.
[b] Weighted average of U.S. tariff on imports from all countries in the world.

Source: Annual Survey of Manufacturing for 1980–2000.
Notes: See the text for construction of variables. All calculations are by the author.

Figure 2. U.S. Real Wage per Worker, 1980–2000

Source: Annual Survey of Manufacturing for 1980–2000.

Notes: See the text for construction of variables. All calculations are by the author.

Figure 3. Relative Wage of Skilled to Unskilled Workers, 1980–2000

For the modeling of the specification of the first-stage regression, assume that p_{jt} (U.S. domestic product prices for industry j at time t) depends on trade barriers, U.S. import variables, and U.S. industrial variables. U.S. tariffs and transportation costs are used for trade barriers; the exchange rate between U.S. currency and foreign currencies are used for the import variable; and TFP, U.S. output share, and the capital-labor ratio are used for U.S. industrial variables. Table 2 summarizes statistics (mean and standard deviation) for all variables.

Then, the estimating equation (first-stage regression) for explaining p_{jt} is given by:

$$\log(p_{jt}) = \alpha_1 \cdot Tariff_{jt}^{c} + \alpha_2 \cdot Tariff_{jt}^{row} + \alpha_3 \cdot Trans_{jt}^{c} + \alpha_4 \cdot Trans_{jt}^{row}$$

$$+\alpha_5 \cdot TFP_{jt} + \alpha_6 \cdot Outputshare_{jt} + \alpha_7 \cdot KLratio_{jt} + \alpha_8 \cdot Exrate_{jt}^{twei}$$

$$+\delta \cdot D_j + \varepsilon_j$$

Here, j is the industry and has 100 industries. t is the year from 1980 to 2000. Superscript c represents a country, Canada or Mexico. p_{jt} represents product prices for industry j at time t. Value-added prices in each industry are used following Haskel and Slaughter (2003). $Tariff_{jt}^{c}$ is the U.S. tariff rate on imports from country c for industry j at time t. $Tariff_{jt}^{c}$ is calculated as total duties collected as a share of total customs value of imports for consumption.[6] $Tariff_{jt}^{row}$ is the U.S. tariff rate on imports from the rest of the world (all countries except country c) for industry j at time t. $Trans_{jt}^{c}$ and $Trans_{jt}^{row}$ are transportation costs for import of industry j at time t from country c and from the rest of the world (all countries except c). $Trans_{jt}^{c}$ and $Trans_{jt}^{row}$ are calculated as import charges[7] as a share of total customs value of imports for consumption. TFP_{jt} is total factor productivity[8] for industry j at time t. $Outputshare_{jt}$ is the share of U.S. output for industry j in total manufacturing industry at time t. $Outputshare_{jt}$ is calculated by U.S. output as a share of total manufacturing industry output. U.S. outputs for industry j are represented by the amount of value added for industry j, while total manufacturing industry outputs are by amount of total value of shipments in manufacturing industries. $KLratio_{jt}$ is the capital-labor ratio for industry j. $Exrate_{jt}^{twei}$ is the exchange rate for the trade-weighted exchange index with major currencies areas such as Euro area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden from the Economic Data-Fred® by the Federal Reserve Bank of St. Louis. D_j represents industry dummy variables. A constant term is not included in the specification, to avoid a dummy variable trap. Estimated $\hat{\alpha}_1$ shows how much change in U.S. tariffs on imports from c affects the change in domestic product prices.

Table 2. Summary Statistics for All Variables

	Mean
Product prices (log p)	7.32
	(1.20)
Output share (outshare)	49.97
	(13.70)
TFP (TFP)	1.47
	(0.65)
K/L ratio (KLratio)	25.16
	(21.82)
Exchange rate ($ExRate^{TWEI}$)	99.78
	(13.84)
U.S. tariff rates on Canadian imports ($Tariff^{Canada}$)	2.47
	(3.44)
Transportation costs on Canadian imports ($Trans^{Canada}$)	1.66
	(2.60)
U.S. tariff rates on Mexican goods ($Tariff^{Mexico}$)	2.09
	(3.53)
Transportation costs on Mexican goods ($Trans^{Mexico}$)	2.34
	(4.16)
Factor share for skilled workers	0.07
	(0.04)
Factor share for unskilled workers	0.12
	(0.06)
Factor share for capital	0.04
	(0.03)

Standard deviation in ( ).

For the second-stage regression, three factors of production—unskilled workers, skilled workers, and rental price of capital—are included. Data for production workers in the ASM are used for unskilled workers, and data for non-production workers (total workers minus production workers) in the ASM are used for skilled workers.[9] New capital expenditures and used capital expenditures are summed to calculate total capital expenditure. The regressand of second-stage regression comes from the first-stage regression. $\hat{\alpha}_1 \cdot Tariff_{jt}^{c}$, which is computed in the first-stage regression, is the regressand of second-stage regression. Next, $\hat{\alpha}_1 \cdot Tariff_{jt}^{c}$ is regressed on the factor shares for skilled workers (θ_{sjt}), unskilled workers (θ_{ujt}), and rental price of capital (θ_{rjt}). That is, the specification of second-stage regression is

$$\hat{\alpha}_1 \cdot Tariff_{jt}^{c} = \beta_s \cdot \theta_{sjt} + \beta_u \cdot \theta_{ujt} + \beta_r \cdot \theta_{rjt} + \gamma \cdot D_j + e_{jt}$$

θ_{sjt} is cost share for skilled workers in industry j at time t, θ_{ujt} is cost share for unskilled workers in industry j at time t, and θ_{rjt} is cost share for capital in industry j at time t. Each of these factors is constructed as a share of the total value of shipment, following Haskel and Slaughter (2003). Estimated coefficients $\hat{\beta}_s$ and $\hat{\beta}_u$ are changes in wages for skilled workers and unskilled workers mandated by change in tariffs, working through change of product prices. Taking the difference between $\hat{\beta}_s$ and $\hat{\beta}_u$ gives an estimate of how the reduction of the tariff changes the wage gap.

RESULTS

Tables 3 and 4 report the results of the regression that have been conducted, using the newly developed unique industrial classification code, for the effect of reductions of U.S. tariffs on wages for skilled workers and unskilled workers for 1980 through 2000. Consider the first-stage regression (Table 3) showing the correlation between product price and U.S. tariffs.

The left column of Table 3 shows the effect of U.S. tariffs on imports from Canada on product price. It shows that if the tariff rate changes by 1 percent, product price ($\hat{p}$) changes by about –0.008 percent. Product prices are negatively correlated with the U.S. tariff on Canadian imports. This correlation is statistically significantly different from zero. The trade barrier variable $Tariff_{jt}^{row}$ has a statistically significant effect on product prices, whereas other trade barrier variables ($Trans_{jt}^{c}$, $Trans_{jt}^{row}$) have statistically insignificant effects on product prices. The import variable, $\Delta \log Exrate_{t}^{twei}$, and domestic industrial variables (TFP_{jt} , $Outputshare_{jt}$, $KLratio_{jt}$) show statistically significant effects on change in product prices at the 1 percent level. The right column showing the effect on product price of U.S. tariffs on imports from Mexico is read in the same manner. It shows that if the tariff rate changes by 1 percent, product price ($\hat{p}$) changes by about –0.009 percent. The same results for other variables were obtained for Mexican imports.

Table 3. First-stage Regression Results

Regression Results (1st Stage)

	(Dependent Variable: log P)	
	c is Canada	*c* is Mexico
$Tariff^{c}$	–0.0076***	–0.0088***
	(5.94)	(6.34)
$Trans^{c}$	0.0021	–0.0005
	(1.46)	(0.62)
$Tariff^{Row}$	–0.0063***	–0.0077***
	(4.70)	(5.77)
$Trans^{Row}$	–0.0006	–0.0002
	(0.77)	(0.14)
TFP	–0.6161***	–0.7508***
	(24.62)	(29.67)
Outshare	0.0494***	0.0544***
	(43.63)	(50.22)
KLratio	0.0007***	0.0012***
	(3.89)	(7.01)
$ExRate^{Twei}$	–0.0009***	–0.0010***
	(3.85)	(4.98)
R-sq.	0.9993	0.9995
Obs.	1804	1728

(XXX) shows absolute t-statistics.
*** Shows significance at 1% level.

To estimate wage changes mandated by U.S. tariffs working through product price changes, the second-stage regressions need to be estimated (Table 4).

Consider first the left column in Table 4, which shows the effect on the wage gap of product prices mandated by the change in U.S. tariff on imports from Canada. It indicates that a 1 percent reduction of tariff, working through product prices, mandated a rise in the wage for skilled workers ($\hat{\beta}_s$) by 0.09 percent and mandated a fall in the wage for unskilled workers ($\hat{\beta}_u$) by 0.60 percent, resulting in a mandated rise in the wage gap ($\hat{\beta}_s > \hat{\beta}_u$) by 0.69 percent. These results, except the rise in the wage for skilled workers, are statistically significantly different from zero. A similar result is obtained when the effect on the wage gap of product prices mandated by the U.S. tariff on Mexican imports is estimated (right column). A 1 percent reduction of tariff mandated a rise in the wage for skilled workers ($\hat{\beta}_s$) by 0.08 percent and mandated a fall in the wage for unskilled workers ($\hat{\beta}_u$) by 0.58 percent, resulting in a mandated rise in the wage gap ($\hat{\beta}_s > \hat{\beta}_u$) by 0.57 percent.

Table 4. Second-stage Regression Results

	Regression Results (2nd Stage) (Dependent variable: log P induced by tariff rate)	
	U.S.–Canada	U.S.–Mexico
Wage (Skilled Workers): $\hat{\beta}_s$	0.085	0.008
	(0.39)	(0.04)
Wages (Unskilled Workers): $\hat{\beta}_u$	–0.600***	–0.582***
	(2.68)	(3.27)
Rental Price of Capital	0.079	0.1093
	(0.56)	(0.62)
R-sq.	0.725	0.818
Obs.	1804	1728
Wage gap		
$\hat{\beta}_s - \hat{\beta}_u$	0.685*	0.573*
	(1.85)	(1.87)
	Expand	Expand

(xxxx) shows absolute t-statistics.
* significant at 10% level
*** significant at 1% level

This paper finds significant evidence that U.S. tariff reductions on both Canadian imports and Mexican imports expanded wage inequality between skilled workers and unskilled workers in U.S. manufacturing industries from 1980 through 2000. This finding demonstrates that U.S. tariff reductions on Canadian imports and Mexican imports had statistically significant effects on the mandated change in wage gap in U.S. manufacturing industries during the period considered. The result shows a magnification effect; that is, a 1 percent change of tariff rate on Canadian imports caused +0.08 percent change of wage for skilled workers, –0.008 percent change of product price, and –0.6 percent change of wage for unskilled workers ($\hat{\beta}_s > \hat{p} > \hat{\beta}_u$). The same observation can be seen for Mexican imports; that is, a 1 percent change of tariff rate on Mexican imports caused +0.008 percent change of wage for skilled workers, –0.009 percent change of product price, and –0.58 percent change of wage for unskilled workers ($\hat{\beta}_s > \hat{p} > \hat{\beta}_u$). Because of tariff reduction, change of product price has a magnified effect on factor prices. In other words, the relative price of unskilled worker-intensive products to skilled worker-intensive products lowers because of tariff reduction and causes reduction in the wage of unskilled workers and increase in the wage of skilled workers.

Various model specifications are estimated to test the robustness of the results in Tables 3 and 4 in a number of ways. First, a lagged effect between tariff changes and wages is considered. Second, causal variables in the first-stage regression are changed in three ways. The first specification has only a tariff variable as causal variable, the second one has only trade barrier variables (tariff and transportation cost variables), and the third one adds import price variable[10] to the specifications that are conducted. Third, the effect of a weighted average of U.S. tariff cuts on goods from all countries on wages for both types of workers from 1980 to 2000 is tested. Fourth, another combined effect of the U.S. tariff on Canada and Mexico on wages for both types of workers is tested. These tests indicate that the results do not change.

CONCLUSION

This paper, based on the essential idea of Stolper and Samuelson (1941) and following the mandated wage methodology with two-stage procedure of Haskel and Slaughter (2003), examined whether the reduction of U.S. tariffs, working through product prices, raised the wage gap between skilled workers and unskilled workers in U.S. manufacturing industries from 1980 through 2000. The effect of U.S. tariff reductions on imports from Canada and Mexico on wages for both types of workers was estimated, using the newly developed unique industrial classification code, and verified by various model specifications in a number of ways.

This research found that U.S. tariff reductions on Canadian imports and Mexican imports had a statistically significant effect on mandated change in wage gap in U.S. manufacturing industries from 1980 through 2000. Thus, this paper found significant evidence that U.S. tariff reductions expanded wage inequality between skilled workers and unskilled workers in U.S. manufacturing industries during the period considered. These results showed a magnification effect; that is, the effect of international trade (tariff reduction) on factor prices was larger than the effect on product prices. The result indicated that the U.S. tariff reduction hurts unskilled workers in U.S. manufacturing industries.

This finding does not match the result from Haskel and Slaughter (2003), who found no significant evidence that tariff reductions widened wage inequality in the United States. There are some differences between Haskel and Slaughter (2003) and this paper: (1) Haskel and Slaughter used a weighted average of U.S. tariffs on imports from all countries, whereas this paper focused on NAFTA countries and used U.S. tariffs on Canadian imports and Mexican imports; (2) Haskel and Slaughter considered the period between 1974 and 1988, but this paper examined the 1980 through 2000 so the period after FTA could be included in the analysis, which brings large tariff reduction; and (3) Haskel and Slaughter used Feenstra and Hanson (1997) for correction of variance of estimated coefficient in the second-stage regression, whereas this study used the method of Dumont et al. (2005) so positive variance was guaranteed.

The results of this paper have provided some ideas for future work. First, similar tariff reductions on imports from the United States have been implemented in both Mexico and Canada. It will be worth conducting the same analysis for the relationship between reduction of tariffs and wage inequality in these two countries using the same method. Second, the United States has been reducing tariff rates on imports from many countries and regions other than NAFTA countries. It would be interesting to investigate the effect of those tariff reductions on wage inequality in the United States. Third, it will be interesting to see the same analysis for each state of the United States instead of the whole country. Fourth, it will be interesting to look at another channel other than the tariff-product price channel, such as the tariff-technological channel. Tariff reduction may cause technological change, which may decrease the relative demand for low-skill workers in the United States and thus their relative wages. Fifth, the effects of U.S. tariffs on Canadian wages and Mexican wages can be examined as well. For example, U.S.–Mexico trade is small in volume in terms of U.S. gross domestic product (GDP) but is not small from the Mexican point of view. Thus, the U.S. tariff reductions may affect Mexican wages.

Finally, this paper examined the expanding wage inequality from the U.S. tariff reduction point of view. Although several researchers have previously investigated the effect of U.S. tariff reductions on the increasing wage inequality, this problem still needs to be considered by including other factors.

ENDNOTES

1. First proposed by Feenstra and Hanson (1999).
2. Dumont et al. (2005) improved the correction procedure developed first by Feenstra and Hanson (1997).
3. See Feenstra and Hanson (1997) and Dumont et al. (2005) for this result.
4. More detailed information on the author's unique industrial code is available on request.
5. The author calculated the amount of missing values, which account for about 0.18 percent of total capital expenditure. This level is not crucial.
6. The custom value for 1989 through 2000 has two types—imports for consumption and general imports—whereas the custom value for 1980 through 1988 has only one type, imports for consumption. The author has therefore used "custom value, imports for consumption" for this analysis for consistent point of view.
7. Import charge is not listed in Feenstra (1996) for 1980 through 1988. It has therefore been constructed here by calculating [(CIF value) – (custom value)]. Please note that there are some observations reporting CIF value smaller than the custom value, in which case transportation costs are set equal to zero. Also, CIF value is not reported in Feenstra et al. (2002) for the period of 1989 through 2000, in which case, CIF value is constructed as [(custom value, imports for consumption) + (import charge)].
8. TFP_j is defined by $TFP_j = \frac{amount\ \ of\ total\ \ value\ \ added\ \ for\ industry\ \ j}{(cost\ share\ for\ industry\ \ j)x\ (total\ \ endowment\ \ \ of\ factor\ \ i)}$, following Leamer (1998).
9. There are many arguments about the classifications for skilled and unskilled workers (Leamer 1994). A category of production workers in the ASM is applied to unskilled workers.
10. It is not proper that import price variable is an explanatory variable in the first-stage regression, because the import price variable and tariff variable are closely correlated, so the import price variable was not included in the main analysis.

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